Injury Patterns in Side Impacts

The Effects of Door Panel Stiffness, Geometry and Intrusions

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Abstract summary of Presentation

Injuries due to side impacts have been studied for some time. Side impacts are a cause of concern since there is less vehicle structure to absorb impact forces. Door panel intrusion is still the most significant contributor in occupant injuries. Before the implementation of the side impact standard, is was likely that the lower door panel would intrude and result in pelvic fractures. At times even a vertical component of the door panel intrusion may occur and result in a sheer fracture of the sacrum. The new side impact standard appears to have minimized the pelvic injuries except when the striking vehicle is a truck, van, SUV or larger vehicle. The upper door is relatively weaker, and thus tends to allow the larger vehicle to ride over the side beams resulting in upper door panel intrusion and a new trend of subsequent thoracic injuries.

Even in crashes in which there is minor intrusion, the occupant may still contact the door panel with potential risks of injury. In an analysis of NASS crash data where low magnitudes of door panel intrusion occurred, it has been shown that the door panel structure remains an injury source in side impacts. The design and geometry of the interior door panels varies among makes and models with some having full flat surfaces while others have protruding stiff narrow armrests. The narrow armrest may have the potential to contribute to abdominal injuries above the iliac crest.

The stiffness, geometry and intrusion of door panels in side impacts result in specific injury patterns that will be examined through series of case reviews. - CIREN SEATTLE

Factors influencing injury in side impacts

1. **Intrusion = Injury**

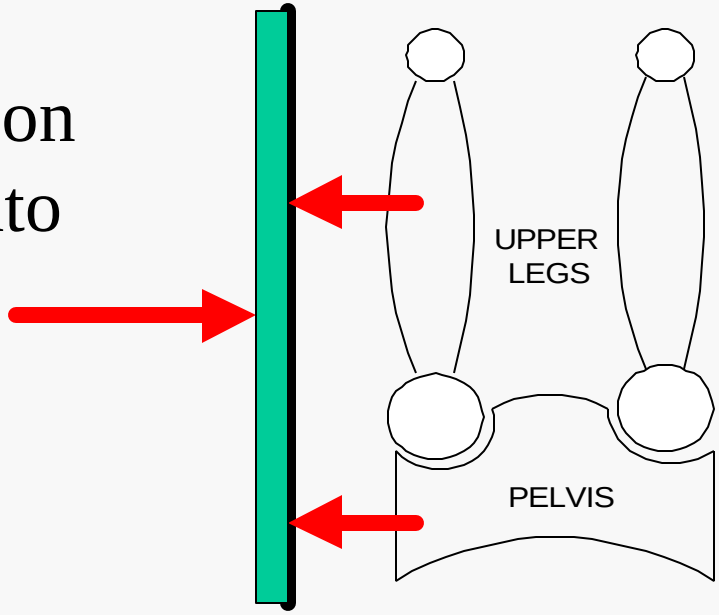
2. Side impacts below the of side impact beam protection can result in lower door panel “swivel” intrusion creating a possible vertical component of force on the pelvis

3. Larger vehicle impacts collapse upper door panels over side impact beams and increase thoracic injuries (SUV vs.Compact)

4. Door geometry including armrest stiffness

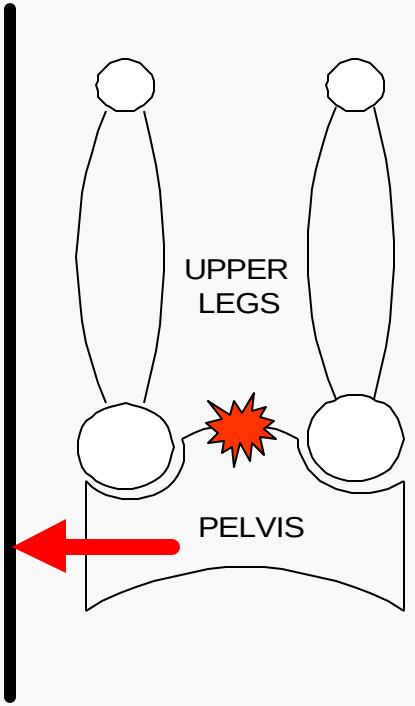
Side Impact Forces

Direct intrusion of surfaces into the occupant compartment



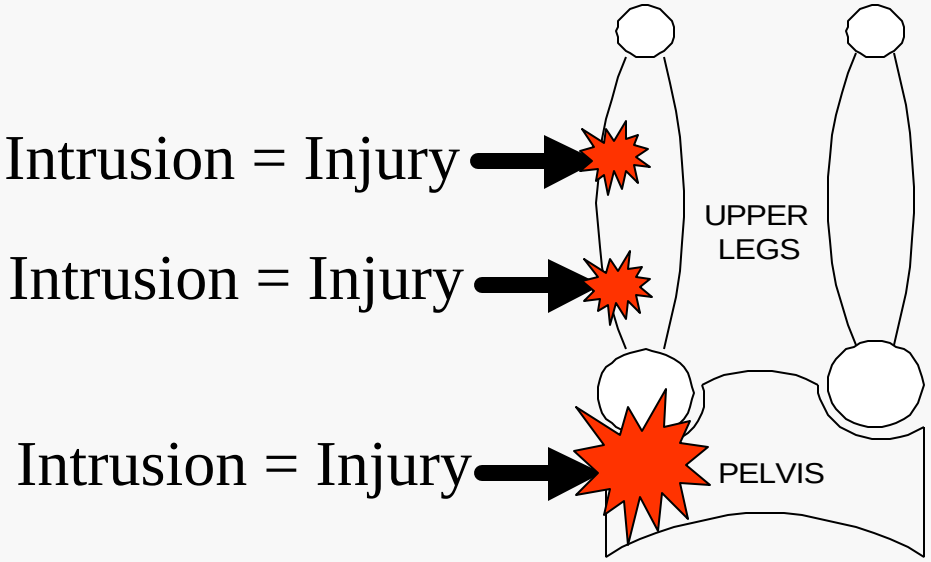
Occupant movement and collision with the interior surface

Direct Contact Forces from Occupant Movement



Occupant movement into door panel may cause pelvic fractures and other body region injuries with minimal intrusion

Direct contact forces from side impact intrusion result in injuries



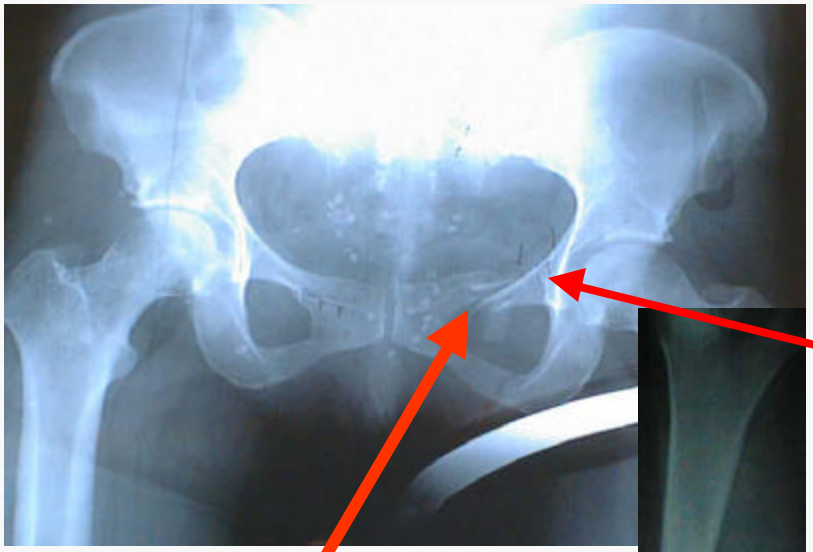
Any point of lateral intrusion generally results in injury at that point.

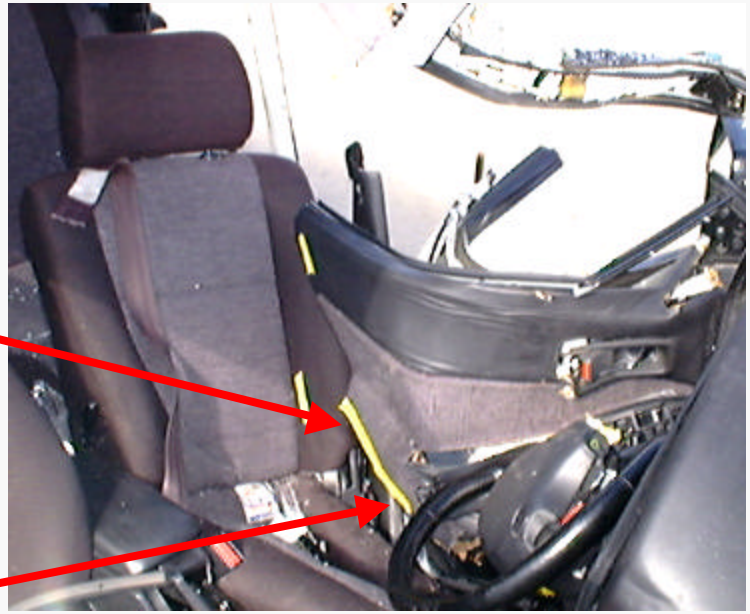
Intrusion = Injury

Intrusion = Injury Example

Intrusion Case Review

Intrusion Case Review



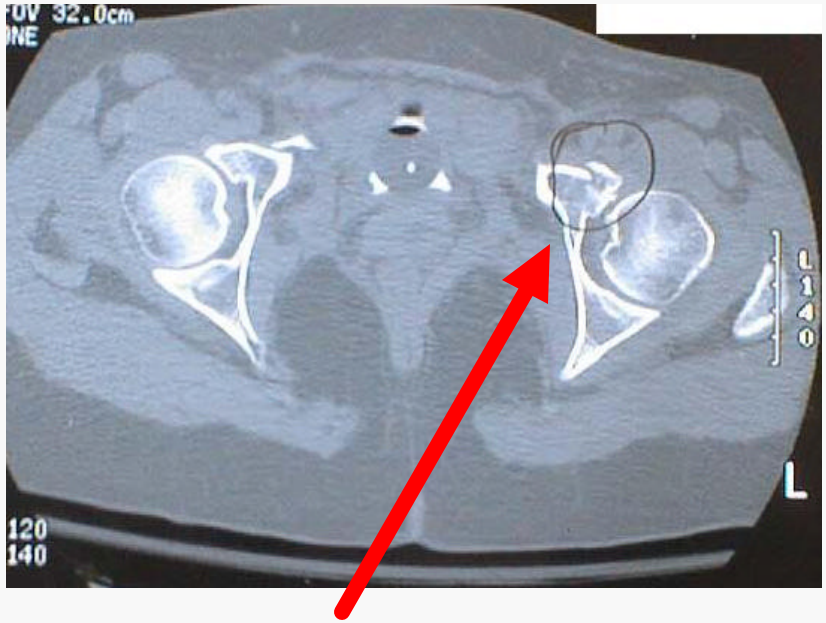


Pelvic fx

Left Femur Fx

Lateral door intrusion

Lower lateral door intrusion

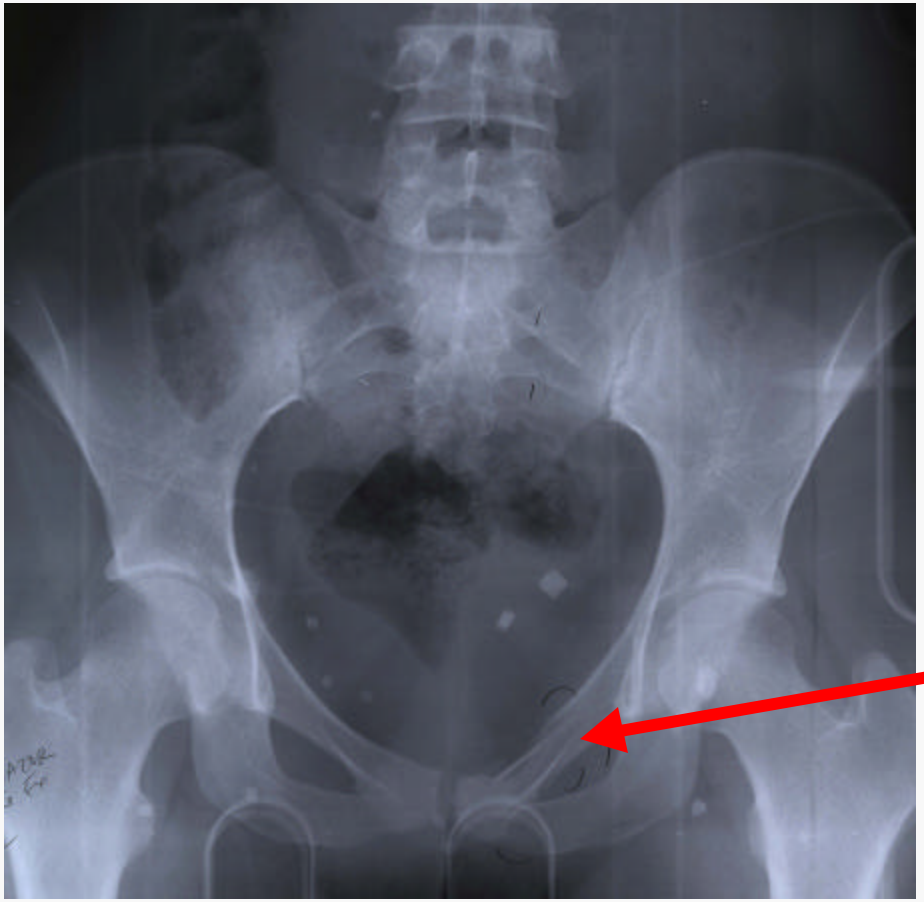


Left acetabular fx

Lateral Door Intrusion

Lower door panel intrusion

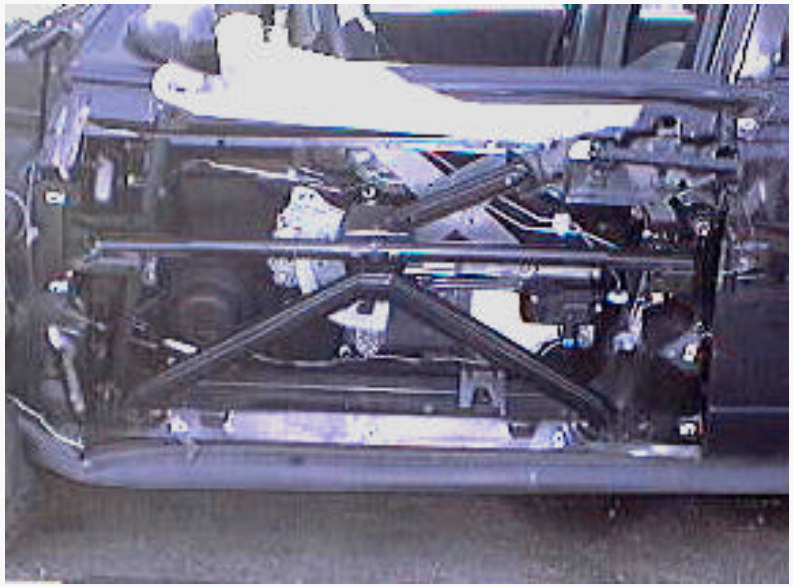
Lateral compression fracture

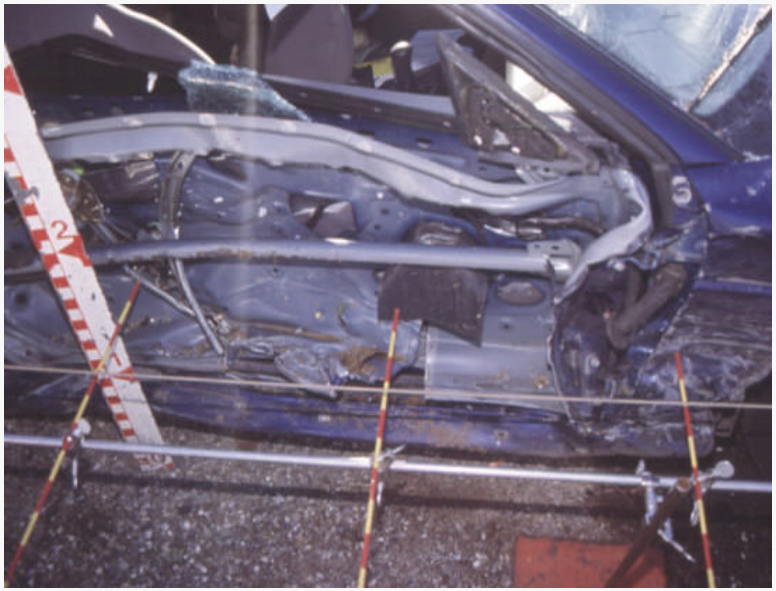


Comminuted

pubic rami fracture

Side impact standard improvements





Use of side impact beams in doors

Factors influencing injury in side impacts

1. Intrusion = Injury

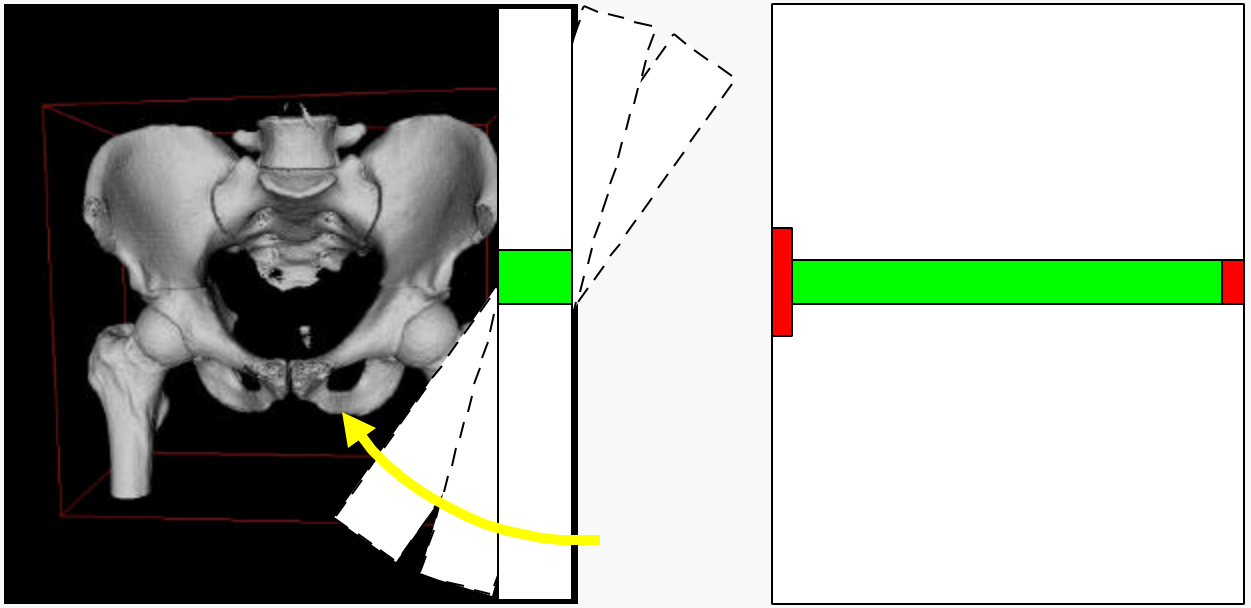
2. Side impacts below the of side impact beam protection can result in lower door panel "swivel" intrusion creating a possible vertical component of force on the pelvis

3. Larger vehicle impacts collapse upper door panel over side impact beams and increase thoracic injuries (SUV vs.Compact)

4. Door geometry including armrest stiffness

Even with the side impact beam, door panel intrusion can result in a possible vertical loading on the pelvis

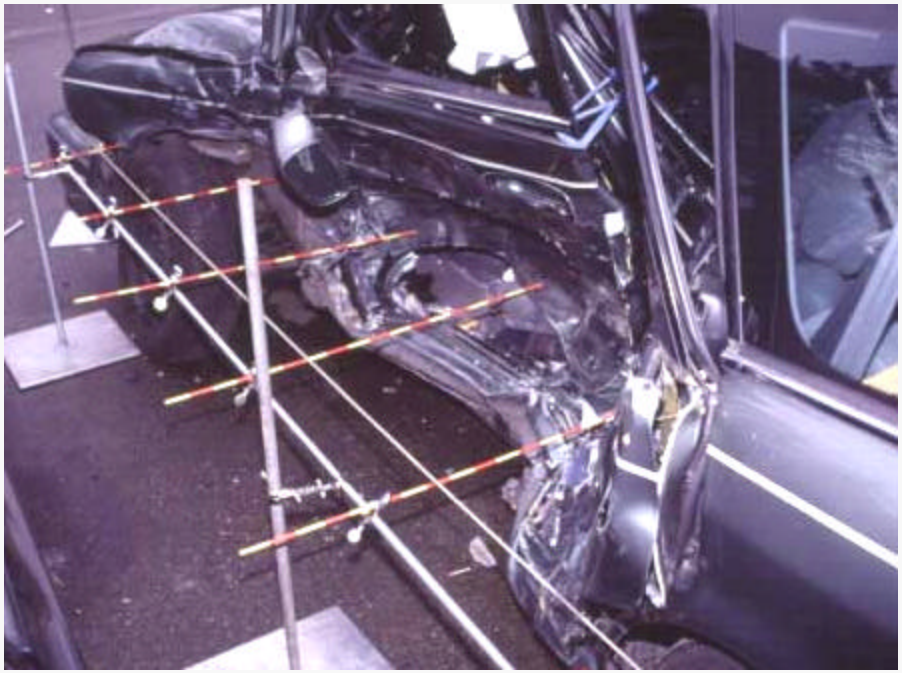
Vertical loading component with use of side impact support beam



End View **Side View**

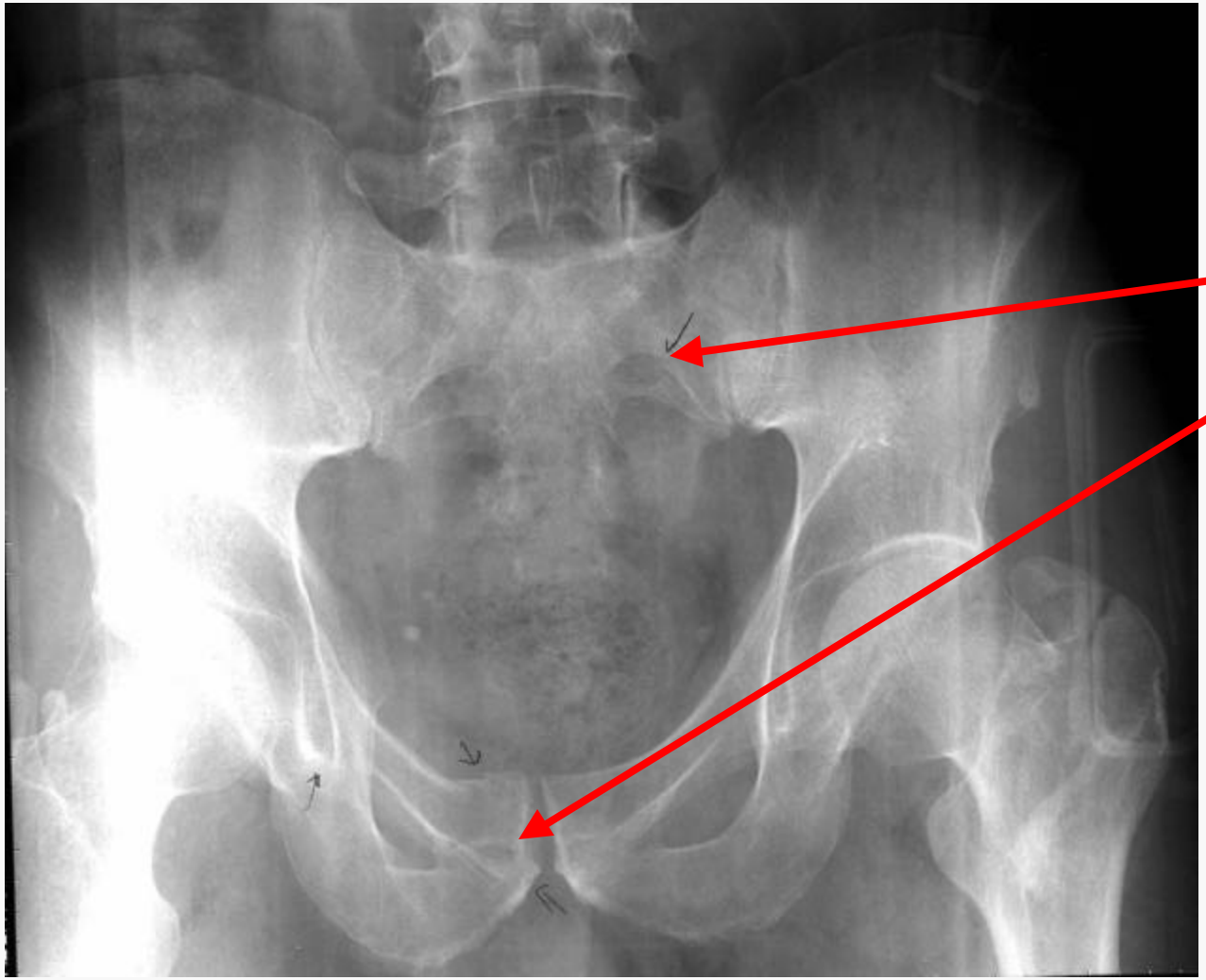
Vertical loading of the pelvis can result in **shear** fracture of bone at the front (pubis) and back sacroiliac joint or sacrum

Vertical loading case review



Door intrusion seems to have a vertical component

Vertical loading case review



Factors influencing injury in side impacts

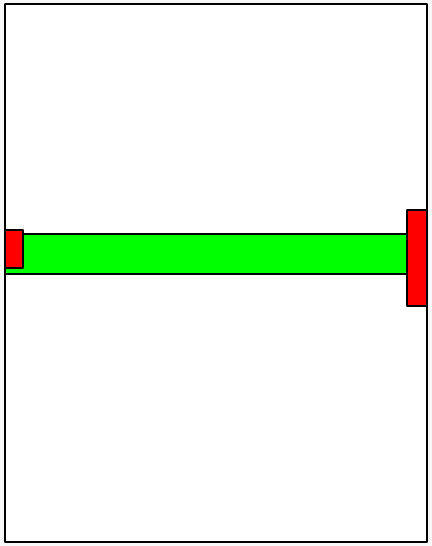
1. Intrusion = Injury

2. Side impacts below the of side impact beam protection resulting in lower door panel “swivel” intrusion creating a possible vertical component force on the pelvis

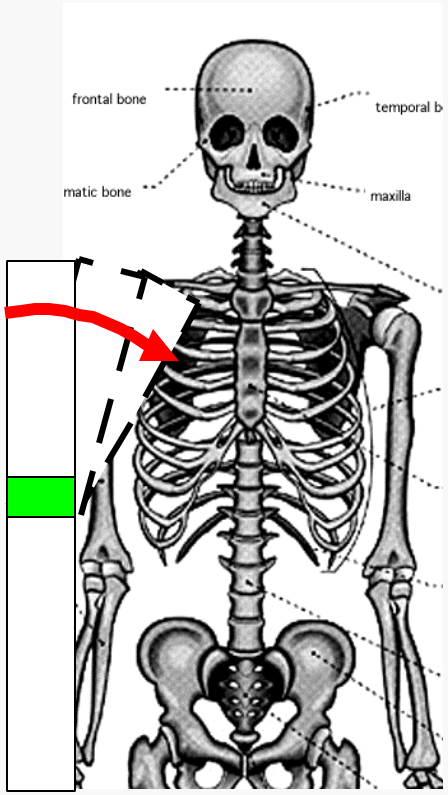
3. Larger vehicle impacts collapse upper door panel even over side impact beams and increase thoracic injuries (SUV vs.Compact)

4. Door geometry including armrest stiffness

Side impacts with larger vehicles with lateral door support beams



Side View



End View

Upper door panel intrusion

1998 Subaru Impreza vs. SUV

Most large trucks, vans, and SUVs will collapse the upper door panel, and even override the support beam

Upper door panel intrusion Case review

Injury Summary

- R rib fx #3-10

- L rib fx # 1-3

- R Hemothorax

AIS = 5

Delta V = 20 mph

(Also serious head trauma)

1996 Toyota Corolla

Factors influencing injury in side impacts

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3. Larger vehicle impacts collapse upper door panel over side impact beams and increase thoracic injuries (SUV vs.Compact)

4. **Door geometry including armrest stiffness**

Various geometric shapes of interior door panel designs

Door Panel Geometry

Armest with the panel extended downward

Door Panel Geometry

Protruding armrests

Door Panel Geometry

Stiff door handles

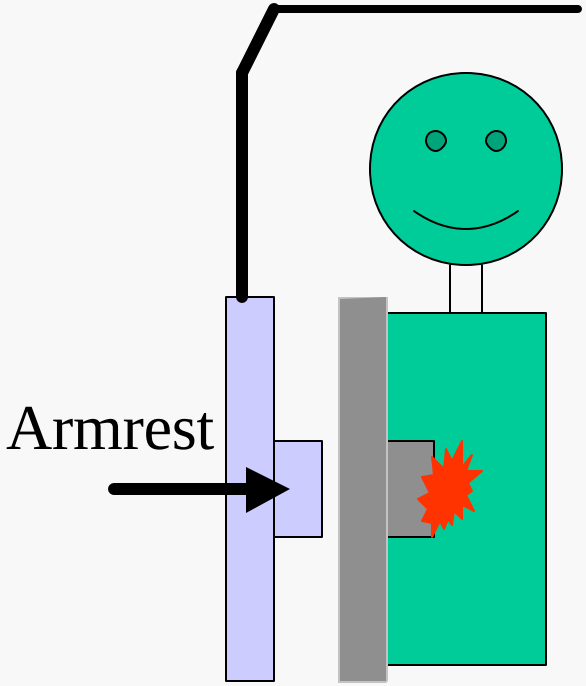
Door Panel Geometry

Flat door handles and no armrest

Abdominal Injuries Observed

- Side impacts appear to increase the risk of abdominal injuries

- The stiffness and geometry of the door panels along with the protruding components, such as the armrest appear to become forced into the abdomen of the occupant.



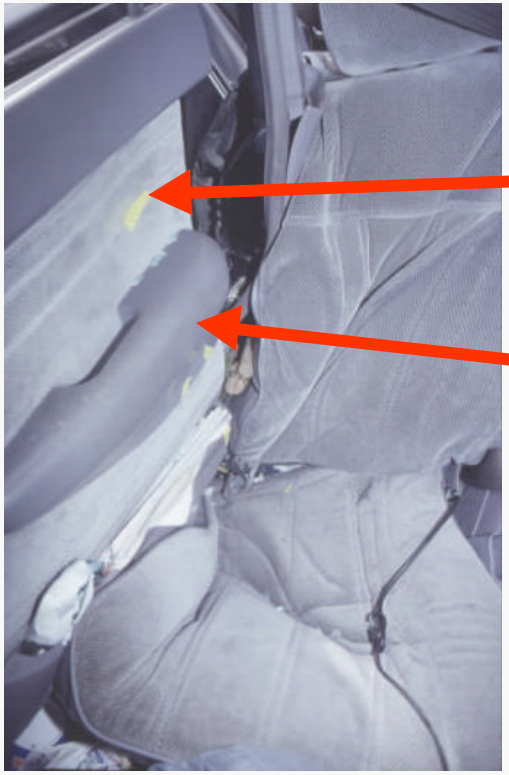
Abdominal injury case review

Injuries associated with stiff armrest:

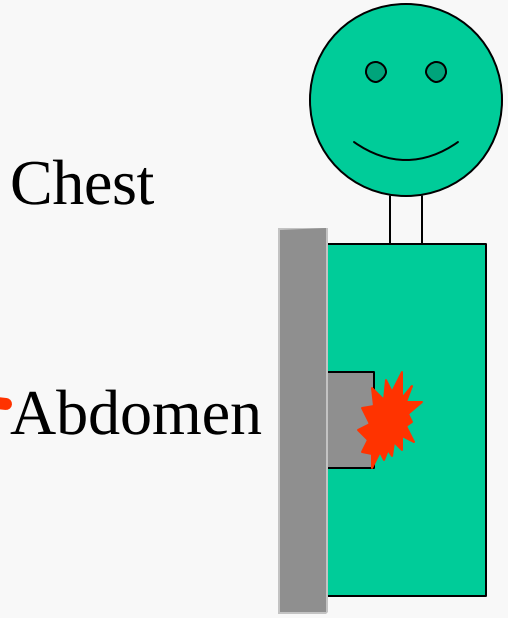
R kidney laceration

Liver laceration

Other: Splenic laceration, Flail chest , ruptured aorta



1994 Ford Escort



Abdominal Armrest Injury Case Review

1998 Jeep Grand Cherokee

Delta V = 15 mph

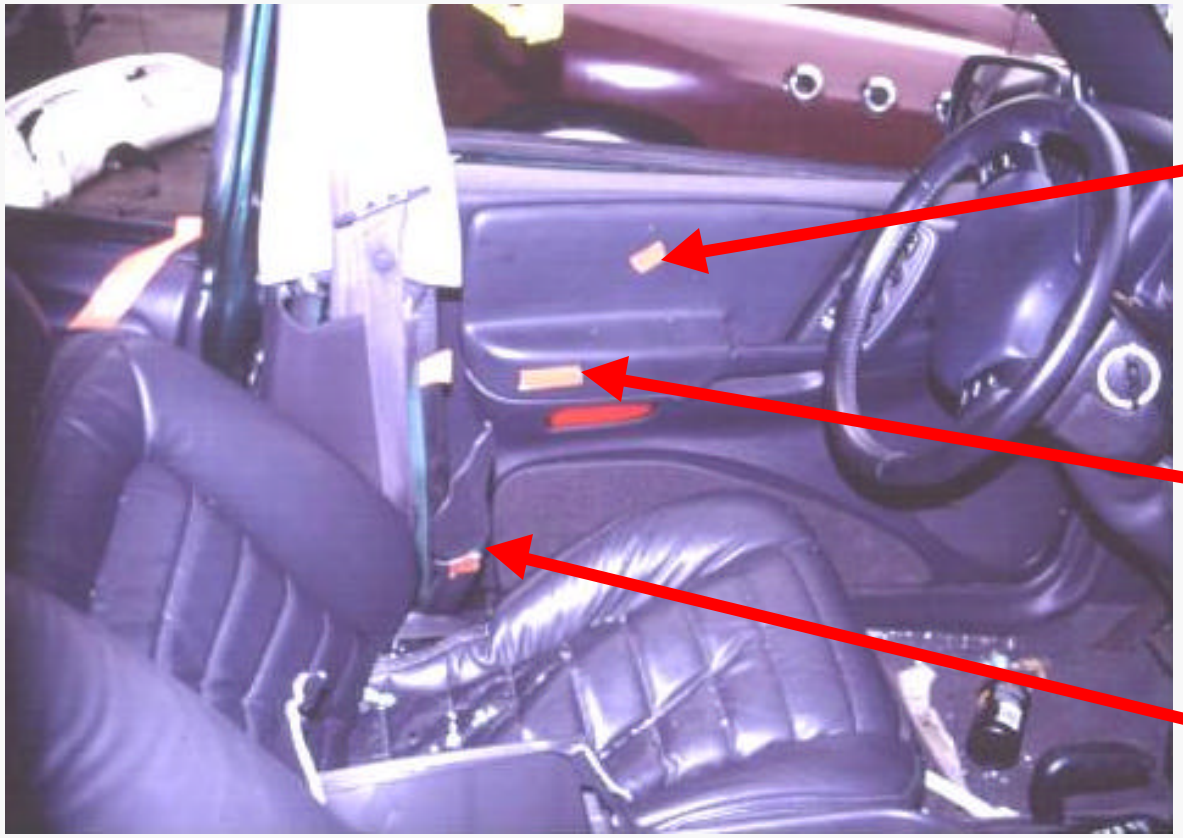
Intrusions

Left B pillar - 22cm - Lat

Driver Door - 16cm - Lat

Roof rail - 12cm - Lat

Occupant Contacts

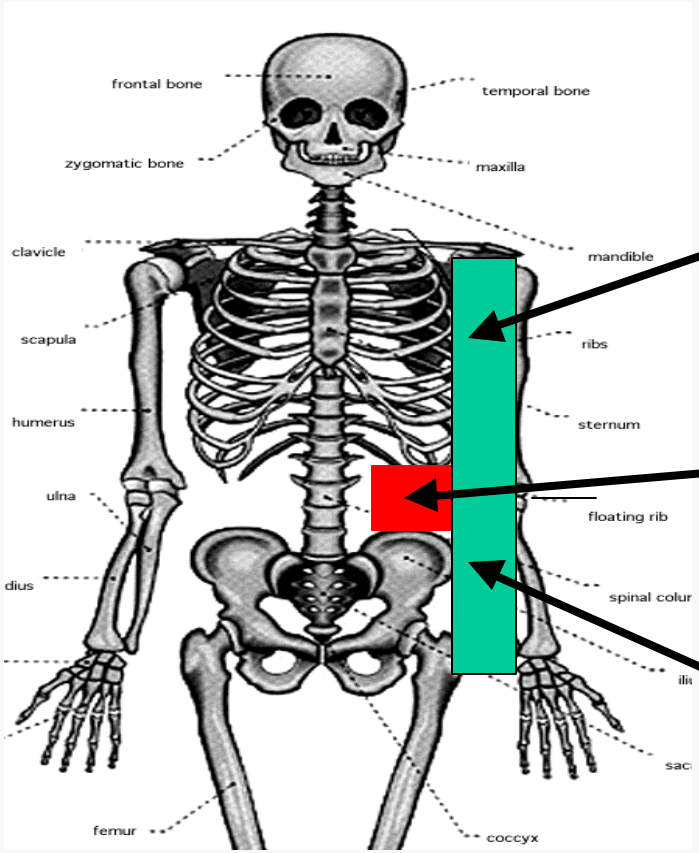


Upper Door Panel Scuff

Protruding Armrest scuffed

B pillar / Door panel cracked

Injury Contacts Observation Summary



L Ribs 2-12 w/ hemothorax

L sup/inf splenic lacerations

L liver laceration

L iliac wing fracture

L pubic ring fracture

Summary

- Intrusion most commonly increases the risk of chest, abdominal, and pelvic injuries
- Stiffness, and geometry of door and side panel structures may also increase risk of injuries